

Chemistry 506: Allied Health Chemistry 2

Chapter 12: Alcohols, Phenols, Ethers, and Halides

Functional Groups with Single Bonds to Oxygen

Introduction to General, Organic & Biochemistry, 5th Edition by
Bettelheim and March: Chapter 12, Pages 391-424

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12A Section(s) 11.1/2/4/7 Introduction and Nomenclature of Alcohols**➤ Methanol**

➤ "Wood alcohol", causes blindness

➤ $\text{CH}_3\text{-OH}$

➤ Ethanol

➤ Oldest man made chemical (history of agriculture)

➤ "Grain alcohol"

➤ $\text{CH}_3\text{-CH}_2\text{-OH}$

➤ Made by sugar fermentation with yeast (wine, beer, gasoline)

➤ Made industrially by Ethene Hydration ($\text{H}_2\text{O}/\text{H}_2\text{SO}_4$)

➤ Isopropanol

➤ "rubbing alcohol"

➤ $(\text{CH}_3)_2\text{CH-OH}$

➤ IUPAC Nomenclature

➤ Use anol suffix

➤ Number longest chain to include as many OH groups as possible

➤ Polyols (diol, triol, tetraol, etc.)

➤ Examples

➤ Alcohol Classification

- Primary Alcohols, 1°
- Secondary Alcohols, 2°
- Tertiary Alcohols, 3°

➤ Properties

- Related to Water
- Intermolecular Hydrogen Bonding
- Mp and Bp
- Polar
- Solubility
- Biologically Active

➤ Oxidation

➤ Effects due to class of alcohol

➤ 3° vs. 2° vs. 1°

➤ Effects due to Oxidizing agent Strength

➤ "Generic" Oxidizing Agent, [O]

➤ CrO₃ / pyridine (pyr)

➤ Chromium trioxide

➤ "poisoned" oxidation

➤ K₂Cr₂O₇/H₂SO₄

➤ Potassium Dichromate

➤ "full strength" oxidation

➤ "Weak Oxidation" of 1° Alcohols

➤ Oxidation of Aldehydes

➤ "Strong Oxidation of 1° Alcohols

➤ Oxidation of 2° Alcohols

➤ Failed Oxidation of 3° Alcohols

12C Section(s) 17.2

Biological Alcohols

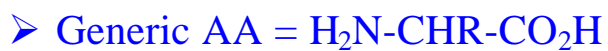
- Glycerol
 - Component of Triglycerides
 - Most common animal and vegetable fats
- Triol
 - $\text{CH}_2(\text{OH})\text{-CH}(\text{OH})\text{-CH}_2(\text{OH})$

12D Section(s) 18.2

Amino Acids having Alcohol Containing

Side Chains

➤ Amino Acids (Building Blocks of Proteins)



➤ Serine



➤ Threonine



12E Section(s) 12.5/7 Phenols**➤ Aromatic Alcohols**

- Originally derived industrially from **coal tar**
- Generic Structure (Aromatic-OH)

➤ Properties

- Often **unpleasant odors**
- **Intermolecular Hydrogen Bonding**
- **Mp and Bp**
- **Solubility**
- **Toxicity**
- **Acidity** (cf. **Alcohols**)

➤ Phenol (C_6H_5-OH)

➤ Cresol (ortho, meta, and para-methyl phenol)

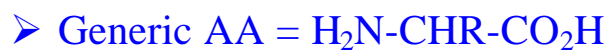
- Many **Natural Products**
 - **Lignins** in wood
 - **Pulp mill effluent**
 - **Aerobic oxidation**
 - **"Trout test"**

 - **Vanillin** (1-OH, 2-OCH₃, 4-CHO)

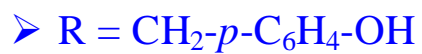
12F Section(s) 18.2

Amino Acids having Phenol Side Chains

➤ Amino Acid



➤ Tyrosine



12G Section(s) 12.6/7 Ethers

- R-O-R Structure
 - Bond angles $\approx 109.5^\circ$

- Physical Properties
 - Mp and Bp vs. Alcohols
 - Polarity
 - Hydrogen Bonding (cf. Alcohols and Water)
 - Solubility

- Nomenclature
 - Dialkyl Ether (two words)
 - Alkyl Alkyl' Ether (three words)

- Chemical Reactivity
 - Generally very low
 - Used as Solvents

- Diethyl Ether
 - $\text{CH}_3\text{-CH}_2\text{-O-CH}_2\text{-CH}_3$
 - "ether", "ethyl ether"
 - Anaesthetic
 - Made from grain alcohol and acid

- THF (tetrahydrofuran)
 - Made from Oat husks, Quaker Oat Company
 - Used to make specialty plastics (car dashboards)

- Ethylene Oxide
 - Exceptionally reactive due to ring strain
 - Medical sterilization

- MTBE (methyl tertiarybutyl ether)

12H Section(s) 12.8

Thiols, Thioethers, and Disulfides

- Cf. **Hydrogen Sulfide (H₂S)**

- **Stink and Toxic**

- **Thiols (Mercaptans)**
 - R-S-H

 - **Pentanethiol (CH₃CH₂CH₂CH₂CH₂-SH), skunk oil**

- **Thioethers**
 - R-S-R

- **Disulfides**
 - R-S-S-R

Problems: 12.1 to 12.37

12I Section(s) 18.2 Amino Acids having Sulfur Containing
Side Chains

➤ Amino Acids (Generic AA = $\text{H}_2\text{N}-\text{CHR}-\text{CO}_2\text{H}$)

➤ Cysteine (neutral polar)

➤ $\text{R} = \text{CH}_2-\text{SH}$

➤ Cystine

➤ $\text{CH}_2-\text{S}-\text{S}-\text{CH}_2$ bridge

➤ Methionine (non-polar)

➤ $\text{R} = \text{CH}_2\text{CH}_2-\text{S}-\text{CH}_3$

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